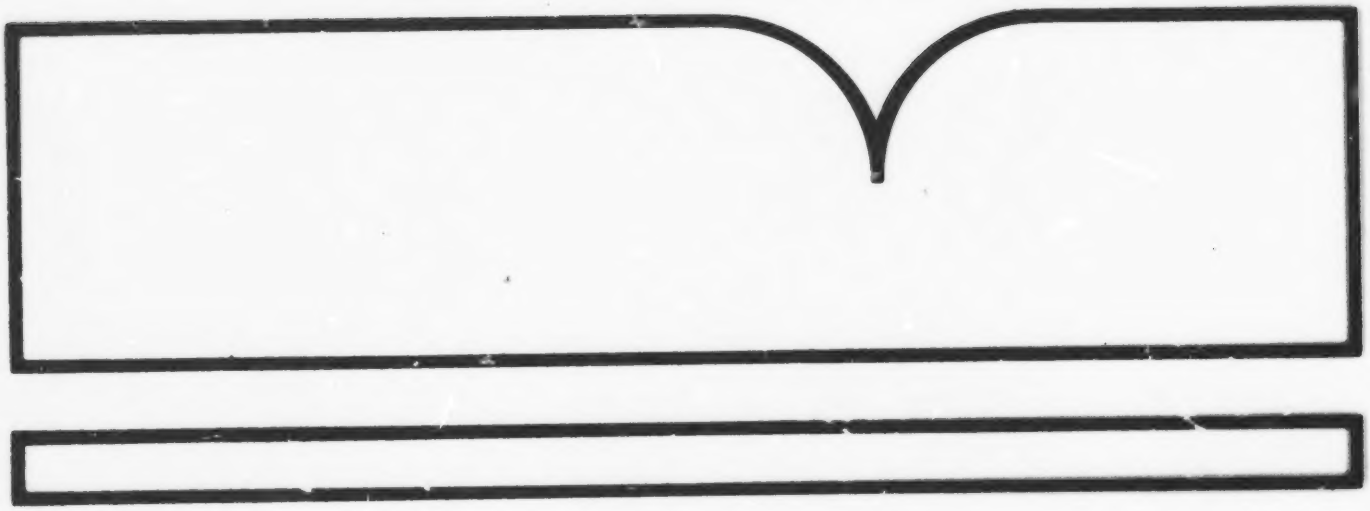
PB90-137332

Ecological Risk Management in the Superfund and RCRA (Resource Conservation and Recovery Act) Programs

(U.S.) Environmental Protection Agency, Washington, DC

Jun 89



U.S. Department of Commerce
National Technical Information Service
NTIS

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO. EPA-230-03-89-045	2.	3. Recipient's Accession No. PB90-137332
4. Title and Subtitle: Ecological Risk Management in the Superfund and RCRA Programs			5. Report Date: June 1989
			6.
7. Author(s): Craig Zamuda			8. Performing Organization Rept. No.
9. Performing Organization Name and Address			10. Project/Task/Work Unit No.
			11. Contract(C) or Grant(G) No. (C) (G)
12. Sponsoring Organization Name and Address: Office of Policy Analysis (PM-220), U.S. Environmental Protection Agency, Washington, D.C. 20460			13. Type of Report & Period Covered
			14.

15. Supplementary Notes

16. Abstract (Limit: 200 words)

This report discusses the extent to which ecological concerns have been used as a basis for decisionmaking in the CERCLA and RCRA programs. For each program, the report first identifies areas in which ecological impacts could be considered, and then examines the manner and extent to which ecological concerns have, in fact, been taken into account in program activities. This report concludes with discussion of the major ecological risk management issues that should be addressed by the Agency if ecological concerns are to be fully considered in the RCRA/CERCLA decisionmaking.

17. Document Analysis a. Descriptors

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement: No restriction on distribution. Available from NTIS Springfield, VA 22161	19. Security Class (This Report): unclassified	21. No. of Pages
	20. Security Class (This Page): unclassified	22. Price

(See ANSI-Z39.18) See Instructions on Reverse OPTIONAL FORM 272 (4-77)

United States
Environmental Protection
Agency

Office of Policy
Planning and Evaluation
(PM-220)

EPA-230-03-89-045
June 1989

EPA

Ecological Risk Management In The Superfund And RCRA Programs

PB90-137332

REPRODUCED BY
U.S. DEPARTMENT OF COMMERCE
NATIONAL TECHNICAL INFORMATION SERVICE
SPRINGFIELD, VA. 22161

EPA-230-03-89-045

ECOLOGICAL RISK MANAGEMENT IN THE SUPERFUND AND RCRA PROGRAMS

Office of Policy Analysis
Office of Policy, Planning, and Evaluation
U.S. Environmental Protection Agency
Washington, D.C.

June 1989

ACKNOWLEDGEMENTS

This document was developed by EPA's Office of Policy Analysis (OPA) within the Office of Policy, Planning, and Evaluation. Dr. Craig Zamuda was the EPA project director, with support provided by Dr. Dexter Hinckley, Mr. Mike Cox, and Mr. Ron Benioff.

ICF Incorporated assisted OPA in development of this document. The ICF project team was directed by Joanne Colt and Bill Ward, and included Charles Chappell, Simon Heart, Michael Troyer, Steve Wyngarden, Randy Freed, and Baxter Jones.

The authors of this document wish to acknowledge, with appreciation, the inputs, cooperation, and review provided by the many other people who contributed to the project. This includes numerous individuals within the Department of the Interior (Fish and Wildlife Service and Office of Environmental Project Review), the National Oceanic and Atmospheric Administration, all ten EPA Regions, EPA Laboratories, EPA Headquarters, and several State organizations.

TABLE OF CONTENTS

		Page
1.	INTRODUCTION	1
2.	INFORMATION SOURCES	2
3.	ECOLOGICAL RISK MANAGEMENT IN THE RCRA PROGRAM	3
	3.1 Regulatory Development and Program Review	3
	3.2 Hazardous Waste Definition and Determinations	8
	3.3 Subtitle C Permitting	9
	3.4 Subpart F Corrective Action	12
	3.5 Subpart S Corrective Action	15
4.	ECOLOGICAL RISK MANAGEMENT IN THE CERCLA PROGRAM	21
	4.1 Selection of Sites for the NPL	21
	4.2 Development and Selection of Site Remedies	22
5.	SUMMARY/PROGRAM IMPLICATIONS	35
	5.1 RCRA Programs	35
	5.2 CERCLA Program	36
	5.3 Cross-Program Ecological Risk Management Issues	37

ECOLOGICAL RISK MANAGEMENT IN THE SUPERFUND AND RCRA PROGRAMS

1. INTRODUCTION

This report discusses the extent to which ecological concerns have been used as a basis for decisionmaking in the CERCLA and RCRA programs. For each program, the report first identifies areas in which ecological impacts could be considered, and then examines the manner and extent to which ecological concerns have, in fact, been taken into account in program activities. Explanations are provided for program areas in which ecological risk management appears to be limited, and approaches for improving the collection, evaluation, and management of ecological information are outlined. The report concludes with discussion of the major ecological risk management issues that should be addressed by the Agency if ecological concerns are to be fully considered in RCRA/CERCLA decisionmaking.

This document is organized into four sections. Section 2 discusses the information sources upon which the analysis is based. Sections 3 and 4 discuss the role of ecological risk management in the RCRA and CERCLA programs, respectively. Specific sites are used in Sections 3 and 4 to illustrate how ecological risk management has been conducted in the RCRA and CERCLA programs; the reader is referred to EPA's draft report "The Nature and Extent of Ecological Risks at Superfund Sites and RCRA Facilities," EPA-230-03-89-043 (June 1989) for additional information on most of these sites. Section 5 summarizes the findings, discusses program implications, and identifies ecological risk management issues.

2. INFORMATION SOURCES

A variety of information sources were used to assess past and current ecological risk management in the RCRA and CERCLA programs, including telephone interviews with personnel in EPA and other agencies, meetings with personnel in two EPA Regional offices, and document reviews.

Telephone interviews were conducted with RCRA and CERCLA staff at EPA Headquarters, EPA Regional offices, and the States. These persons were queried on the extent to which decisionmakers seek or are provided with ecological threat information, whether any such information is actually used in decisions, and the major issues involved in ecological risk management. Visits were also made to RCRA offices in EPA Regions 3 and 4, and Georgia's Department of Natural Resources. During these office visits, site-specific file information was collected, and meetings were held with Regional and State personnel to discuss how ecological threat information was being used in the RCRA and CERCLA programs and to identify the main barriers to effective ecological risk management.

For the RCRA program, two types of documentation were reviewed. Several recent Regulatory Impact Analyses (RIAs) and Reports to Congress (RTCs) were reviewed to evaluate the extent to which ecological considerations influence regulatory development. Also included in the review were site-specific documents such as ACL demonstrations, permit applications, RCRA facility assessments, and RCRA facility investigations.

Site-specific Records of Decision (RODs) were reviewed for the CERCLA program, as these provide the rationale for the selection of remedial actions at CERCLA sites. Current and draft RI/FS and ROD guidance documents were also reviewed, as was documentation on the Hazard Ranking System (HRS), a device used to screen sites and establish priorities for action. Both the current HRS and the proposed revisions to the HRS were reviewed. Interviews were also held with Agency personnel in some EPA Regions, and representatives of two Federal agencies that serve as trustees for natural resources under CERCLA (the Department of the Interior, and the National Oceanic and Atmospheric Administration, or NOAA, within the Department of Commerce).

3. ECOLOGICAL RISK MANAGEMENT IN THE RCRA PROGRAM

This section discusses the extent to which ecological considerations have influenced decisionmaking in the RCRA program. The role of ecological risk management in regulatory development and program review is discussed first, followed by a discussion of ecological risk management in four RCRA program areas: hazardous waste definition, permitting, Subpart F corrective action, and Subpart S corrective action.

3.1 Regulatory Development and Program Review

This section focuses on the use of ecological risk information in Regulatory Impact Analyses (RIAs) developed to support RCRA rulemakings, and Reports to Congress (RTC). RIAs serve as an important focal point for evaluating information concerning human health and environmental impacts addressed by RCRA rules. The manner in which RIAs address ecological impacts should, therefore, indicate the general level of emphasis placed on these concerns in the regulatory decisionmaking process. Reports to Congress generally serve as broad policy and program review documentation. Hence, these Reports illustrate the manner in which the Agency measures program impacts, including ecological risk. Although ecological concerns are also considered in other types of documentation supporting regulatory development, such as issue and option papers, background documents, and decision memos, an extensive review of these documents was beyond the scope of this effort.

3.1.1 Background

Executive Order 12291 requires executive agencies to prepare an RIA for all new major regulations. RIAs are used to evaluate the benefits, costs, and economic impacts of proposed rulemakings; RIAs must also assess the potential impacts of regulatory alternatives. EPA develops regulatory analyses under Office of Management and Budget guidelines and has prepared RIAs for many RCRA programs. Reports to Congress are mandated by statute. For example, Section 8002 of RCRA stipulates that EPA is to prepare reports assessing special wastes under RCRA (e.g., mining wastes).

3.1.2 Ecological Risk Considerations in Regulatory Impact Analyses and Reports to Congress

This section briefly summarizes the extent to which ecological risk is considered in RIAs and Reports to Congress, and then discusses ecological risk management in RCRA rulemaking in general.

Regulatory Impact Analyses (RIAs):

- Subtitle D Criteria Revisions RIA - The RIA for the Subtitle D Criteria revisions analyzes the costs and benefits of regulatory options for municipal solid waste landfills. The Subtitle D Risk Model is used to analyze potential releases to ground water and the associated human health risks and ground-water resource damages. The benefits of the regulatory options are evaluated only

in terms of reduction in human health risk from consumption of contaminated ground water, and reductions in water supply replacement costs. Releases to air and surface water are not considered, nor are ecological effects of any kind.

- Corrective Action RIA - The Corrective Action RIA quantifies the societal costs of alternative regulatory approaches, the economic impacts on hazardous waste facilities, and the benefits of increased protection for human health and the environment derived from alternative approaches to corrective action. The RIA also addresses alternatives and strategies associated with facilities experiencing multi-media contamination. The RIA evaluates potential contaminant sources, transport mechanisms, and human health risks, but it does not address ecosystem-based risks as a factor in assessing corrective action alternatives. The benefits analysis focuses entirely on ground-water resource and human health damages associated with alternative approaches for addressing hazardous waste releases. Ecological impacts at RCRA facilities are addressed only through limited case studies and no quantitative information concerning the extent of ecological damage is presented.

- Land Disposal Restrictions for Solvent Wastes RIA - The Solvent Wastes RIA evaluates the impacts of several regulatory approaches for establishing land disposal restrictions for spent halogenated and non-halogenated solvent wastes (EPA waste codes F001-F005). The methods used describe typical release scenarios in relation to human health risk. The RIA does not discuss ecosystem benefits associated with the improved containment of solvents, nor does it attempt to quantify ecological risks posed by releases of these solvents to the environment.

- RIA for Small Quantity Generators - This RIA analyzes the costs, benefits, and economic impacts of rules promulgated for owner/operators generating between 100 and 1,000 kg of hazardous waste per month. The document mentions the threat of hazardous waste releases to the environment and the health risks resulting from different disposal practices, but does not address the ecological risks associated with hazardous waste management by small quantity generators.

- Location Standards RIAs - For the location standards rule, several RIAs were prepared to analyze the costs and benefits of the location standards for several sensitive environments. The benefits measured include reductions in human health risks, water supply replacement costs, corrective action costs, and protection of ecological resources. Ecological effects are, in fact, the primary rationale for regulating hazardous waste management in wetlands and floodplains. The RIA for wetlands measures benefits in terms of reductions in the area of wetlands destroyed, wetland restoration costs, and areal extent of contamination. The floodplains RIA assesses benefits primarily in terms of protection

of aquatic life. Both RIAs rely on case studies to demonstrate the types of effects that can occur in these environments. The baseline ecological damages and regulatory benefits are, in most cases, assessed in qualitative terms only.

Reports to Congress (RTCs):

- Smelting and Refining RTC - This RTC assesses damages from solid wastes associated with the extraction, beneficiation, and processing of primary ores and minerals. Case studies are used to demonstrate instances of soil and water contamination and devegetation. Aquatic toxicity is assessed by comparing waste leachate concentrations to EPA acute ambient water quality criteria for the protection of freshwater aquatic species.

- Mining Wastes RTC - This RTC presents a screening assessment of the risks of mining wastes to human health and the environment. The risk assessment consists of four components: (1) evaluation of waste quantity and composition, (2) fate and transport modeling for air, ground water, and runoff, (3) calculation of human health risk, and (4) comparison of simulated pollutant levels in surface water to ambient water quality criteria. The RTC also assesses the proximity of active mining sites to sensitive environments.

- Oil and Gas RTC - This RTC estimates the range of human health and environmental impacts associated with management of wastes generated during the exploration, development, or production of oil, natural gas, and geothermal energy. Case studies are presented to demonstrate instances of contaminated surface water and soil, vegetation kills, death of birds and small mammals, damage to aquatic life, and bioaccumulation in oyster beds. A quantitative risk assessment evaluates the potential for damages to human and aquatic receptors. The RTC also assesses the proximity of oil and gas sites to sensitive environments.

- Coal Utilities RTC - This RTC assesses the economic impacts and potential dangers to human health and the environment associated with the management of wastes generated from the combustion of coal by electric utility power plants. The document presents case studies to qualitatively demonstrate potential human health risks and ecosystem damage. It also examines the proximity of coal utilities waste sites to sensitive environments containing Federally-designated rare or endangered species. No quantitative assessments of ecosystem effects are included in the analysis.

The review of RIAs and Reports to Congress indicates that reductions in human health risk, rather than protection of the environment, provide the justification for most RCRA rulemakings. This conclusion is supported by a review, performed as part of this project, of all major RCRA Federal Register notices from 1979 to the present; this review indicated that the threat of ecological damage is rarely used as the primary basis of support for regulations affecting RCRA facilities. Although rulemakings are implicitly

intended to protect human health and the environment, their justification is usually based upon human health risk assessments for quantitative measures of benefit. Discussions of ecological benefits are addressed qualitatively.

Exhibit 3-1 summarizes the ecological considerations that are discussed in recent RIAs and Reports to Congress. This exhibit also identifies the primary factors considered in the benefits analyses (i.e., protection of human health or the environment) presented in each of these RIAs and reports. Although the exhibit indicates that ecological risks have been considered in several of the documents, these discussions are generally limited to qualitative assessments or limited quantitative analyses.

3.1.3 Discussion

Several factors contribute to the absence or inconsistent use of ecological concerns in RIAs and Reports to Congress. First, policy and guidance for the consideration of ecological or environmental parameters in RIAs is insufficient. Current Agency guidance for preparing RIAs (see EPA Document # EPA-230-01-84-003) describes direct methods for assessing damages to environmental resources of known economic value, and other methods, which rely on proxy measures of economic value, for estimating the costs for replacing environmental resources of unknown value. These methods include:

- Direct cost - measurements of damages to fisheries, forests, and agriculture,
- Travel cost - estimates of the value of improved recreational effects of reduced pollution,
- Property value - relates differences in property values between areas with different environmental characteristics to infer the value placed on environmental improvements, and
- Contingent valuation - only available method for evaluating impacts to nonmarket goods -- requests information from individuals concerning their willingness to pay to enjoy alternative levels of environmental quality.

These methods rely on estimating benefits in terms of preventing damage to recreational areas or ecological resources with known value. The guidance does not address impacts to ecological systems without a known value, or systems that people may not be willing to pay to protect. As a result, the guidance implicitly requires that such ecological systems need not be considered. Nonetheless, ecosystems that do not have readily quantifiable economic values may suffer severe impacts from RCRA activities.

Probably the most important reason for the lack of rigorous ecological risk assessment and management is the absence of appropriate methods for quantifying ecological damages on the national level. EPA has used case studies and limited quantitative analysis to assess ecological risks at the national level. Although the information generated by these methods is useful in determining the need for a regulation, it cannot be readily assimilated and

EXHIBIT 3-1

ECOLOGICAL CONSIDERATIONS IN SUPPORT OF RCRA RULEMAKINGS

Regulatory Development Document	Ecological Considerations	Ecorisk Considered	Key Factors Considered in Benefits Analysis	Environmental Media Considered
Subtitle D Revised Criteria RIA	None	No	• Human health risks • Ground water resource damage	• Ground water
Corrective Action RIA	• Limited case study analysis • Qualitative discussion of environmental damage	No	• Human health risks • Ground water resource damage	• Ground water
Land Disposal Restrictions for Solvent Wastes RIA	None	No	• Human health risks	• Ground water • Air
Small Quantity Generator RIA	None	No	• Human health risks	• Ground water • Surface water • Air
Location Standards RIAs	• Wetlands RIA considers the area of wetlands destroyed, wetland restoration costs, and areal extent of contamination to wetlands • Floodplains RIA considers protection of aquatic life • Case studies demonstrate damages qualitatively	Yes	• Human drinking water supplies • Aquatic wildlife and wetland ecosystems	• Surface water
Smelting and Refining RTC	• Aquatic toxicity examined • Case studies demonstrate soil and water contamination and devegetation	Yes	• Human health and ecological risks	• Ground water • Surface water
Mining Wastes RTC	• Quantitative and qualitative ecorisk assessment to aquatic receptors • Assesses proximity of sites to sensitive environments	Yes	• Human health and ecological risks	• Ground water • Air • Surface water
Oil and Gas RTC	• Assesses damage to aquatic receptors • Case studies demonstrate ecological damage • Assesses proximity of sites to sensitive environments	Yes	• Human health and ecological risks	• Ground water • Surface water • Soil
Coal Utilities RTC	• Case studies demonstrate ecological damage • Assesses proximity of sites to sensitive environments	Yes	• Human health and ecological risks	• Ground water • Surface water

weighed in certain types of decisionmaking (e.g., quanitifying the benefits of a regulation, selecting among regulatory options). Developing such methods may require long-term research. In the short term, the Agency needs to establish a protocol for considering qualitative measures of ecological impact in regulatory decisionmaking. Such methods may rely on subjective measures of ecological damage provided by expert judgment or other subjective decision analysis techniques.

The following sections describe other activities under RCRA that provide opportunities for consideration of ecological impacts.

3.2 Hazardous Waste Definition and Determinations

3.2.1 Background

The listing program identifies wastes and waste constituents that are to be regulated as hazardous under Subtitle C of RCRA. Wastes and waste constituents are listed as hazardous because they typically and frequently exhibit one or more of the characteristics of hazardous wastes identified in Subpart C Part 261 (ignitability, corrosivity, reactivity, EP toxicity) or meet the criteria for toxicity contained in 40 CFR 261.11(a)(2). These criteria include lethality to humans at low doses, or in the absence of data on human toxicity, a measure of toxicity to laboratory animals. On June 13, 1986, EPA proposed the Toxicity Characteristic (TC) rule. This rule modifies the EP toxicity characteristic procedure by, among other things, adding 38 new chemicals to the list of toxic contaminants of concern and modifying the test leaching procedure for wastes.

40 CFR 260.20 and 260.22 allow persons to demonstrate that a waste from a specific generating facility should be "delisted", i.e., should not be regulated as a hazardous waste. When evaluating a delisting petition, the Agency considers the toxicity of the constituents, their concentration in the waste, their tendency to bioaccumulate, their mobility and persistence, plausible and specific types of management of the waste, the waste quantity generated, and other factors. The decision to delist a waste is based in part on applications of the VHS model, which focuses exclusively on pollutant transport in ground water.

3.2.2 Ecological Risk Management in Hazardous Waste Definition and Determinations

There is little consideration of ecological risk in either the listing or delisting of hazardous wastes. Although ecological impacts are often noted in listing and delisting documentation, there appear to have been no listing or delisting decisions that have been based solely on the potential ecological impacts posed by a waste stream. A limited amount of ecological information is collected and evaluated in the listing and delisting processes. For example, among the criteria for listing a hazardous waste, the Agency may consider the degree to which a constituent in the waste may bioaccumulate, or the "toxic, carcinogenic, mutagenic, or teratogenic effects on humans or other life forms" caused by the constituents (see 40 CFR 261.11). Nonetheless,

potential ecological threat carries very little weight in listing decisions and is secondary in importance to human health considerations.

The proposed TC rule will not increase the extent to which ecological impacts influence the identification of hazardous wastes; the TC regulatory levels are set based on human consumption of contaminated ground water. In general, the delisting program also considers only human exposure via ground-water contamination.

3.2.3 Discussion

Ecological concerns, by regulation, must be considered in the identification or definition of hazardous wastes. Under the RCRA regulations, a waste can be listed for ecological concerns. For example, if a waste contains any of the constituents in Appendix VIII, some of which are included because they are toxic to environmental receptors, the waste can be listed. In practice, though, listing rationales for individual hazardous wastes are virtually always based on human health endpoints.

The use of ecological risk management in the listing, delisting, and characteristic programs could be improved by: 1) developing policy and guidance to direct the consideration of ecological concerns in listing and delisting decisions; 2) developing guidance for Headquarters personnel or petitioners on how to evaluate the ecological effects associated with waste streams, or how to consider ecological damages in listing or delisting decisions; 3) considering environmental effects thresholds as well as human health risk thresholds as the basis for TC regulatory levels; 4) providing guidance to delisting petitioners describing the type of ecological impact data to be reported in petitions; and 5) expanding the delisting modeling approach to consider exposures other than consumption of contaminated drinking water, and to compare predicted pollutant concentrations in the environment to ecological criteria as well as human health criteria.

3.3 Subtitle C Permitting

3.3.1 Background

Under Subtitle C of RCRA, all facilities that treat, store, or dispose of hazardous wastes must obtain a RCRA operating permit. All land disposal facilities were supposed to have been permitted by November 1988, incinerators by November 1989, and other storage and treatment facilities by November 1992. These permits establish the administrative and technical performance standards required at treatment, storage, or disposal facilities (TSDFs). Permitting is the mechanism through which technical standards established under Subtitle C are applied to RCRA facilities.

The permitting process is divided into several steps: submittal of a permit application; administrative review of the application; preparation of the draft permit; incorporation of public comments; and modification, maintenance, and termination of a permit. As part of this project, a limited number of permitting actions were reviewed. The review indicates that if the permit writer does not consider the ecological impacts at a facility, such

considerations generally are raised only by outside parties during the public comment period. At the public comment stage, comments may be received from other government agencies such as the Fish and Wildlife Service and the National Oceanic and Atmospheric Administration (NOAA). EPA or an authorized State agency can grant or terminate an operating permit based on a facility's ability to operate in a manner that is protective of human health and the environment.

3.3.2 Ecological Risk Management in Permitting

The extent to which ecological concerns are addressed in permitting decisions depends largely on the status of the facility seeking a permit. Under current permitting practices, ecological information is not requested from the owner or operator of most new facilities (see 40 CFR Part 270 for a description of RCRA Part B permit application contents). Such information is generally deemed unnecessary because the permitting process is designed to ensure that facilities do not release hazardous wastes to the environment, and the surrounding ecosystems therefore should not be affected. For example, design and operating requirements for various disposal and treatment practices refer to engineered containment to "prevent the migration" of wastes and constituents into the environment (40 CFR Part 264). Nonetheless, certain types of facilities do experience permitted releases to the environment, such as air emissions from thermal treatment facilities or incinerators. In addition, the RCRA Corrective Action RIA estimates that of all active RCRA facilities, 62 percent have experienced a release to the environment that will require a RCRA Facility Investigation. Therefore, some consideration of ecological impacts at permitted facilities appears warranted.

Permits and permit modifications for existing facilities commonly address ecological concerns only when past releases or impacts are observed at a facility. This conclusion is based on discussions with EPA Regional personnel and reviews of permit files. Ecological evaluations performed at existing sites seeking permits are generally for the purpose of evaluating the minimum level of cleanup required to address a past release, rather than the controls needed to prevent future damage. For example:

- A permit modification was requested for Defense General Supply Center, a 640-acre storage facility. The facility encompasses two creeks, a wetland area, a pond, and possible habitat for four endangered species in the vicinity of the waste management areas. An analysis has been performed comparing surface water contaminant levels with chronic freshwater quality criteria. Coincident with the permit modification, the facility operator has proposed to extend facility investigations to include toxicity testing, a wetlands assessment, and an aquatic survey. The proposed ecological assessment at this facility is not designed to determine the controls needed to prevent future ecological damage, but may be used to evaluate the level of cleanup needed to address past releases. The specific information that would provide the basis for such decisionmaking, or the criteria upon which the decisions would be based, are not specified in the proposed workplan or in EPA's preliminary review of the workplan.

Another case illustrates the use of an ecological assessment to identify the permitting conditions needed to prevent future ecological damage; this application of ecological assessment is less common in RCRA permitting:

- This case involves an IRECO Chemicals facility that is currently bound by a compliance order until EPA can set operational standards regulating the explosion of hazardous materials. In the meantime, operation of the facility is subject to general requirements of Subtitle C, plus any conditions prescribed by the Fish and Wildlife Service to protect or mitigate interference with the nesting attempts of several raptors in the proposed RCRA site area. Although this case does represent a more proactive use of ecological information to support permitting decisions, the permit conditions addressing ecological impacts resulted from the Fish and Wildlife Service's involvement in the case. Following informal notification of the proposed permitting action, Fish and Wildlife raised objections with EPA. As a result, EPA requested Fish and Wildlife's assistance in setting the permit conditions.

3.3.3 Discussion

Several approaches to permitting could be adopted to better ensure that ecological impacts are considered at a facility before they become apparent.

- Developing guidelines to require the addition of environmental assessments and exposure information as an integral part of the Subtitle C permit decision process.

There is a need for predictive ecological insight in the Subtitle C permitting process, especially for those facilities thought to pose a moderate to high risk potential by the RCRA program (i.e., land disposal and land treatment facilities; PCB and mixed waste management facilities; and thermal treatment facilities). Since the enactment of HSWA, part B permit applications submitted by owners or operators of landfills and surface impoundments have been accompanied by exposure information and health assessments for the purpose of identifying potential human health problems. However, this exposure information does not include an analysis of potential impacts to environmental receptors and is not actively used in the permitting process. The addition of ecological information in the permit decision process could provide needed foresight to aid in limiting the number of future corrective actions.

- Notifying and allowing other pertinent agencies and experts to take part in the permitting process as early as possible.

There is a need for the early inclusion of expertise from other environmental agencies in the permitting process. This is especially true for agencies such as the Fish and Wildlife Service, NOAA, and others which administer Federal laws that have the potential to impact the RCRA permitting process (i.e., Wild and Scenic Rivers Act, Endangered Species Act, Coastal

Zone Management Act, Fish and Wildlife Coordination Act, and the National Historic Preservation Act of 1966. See 40 CFR Section 270.3).

3.4 Subpart F Corrective Action

3.4.1 Background

Under current Subtitle C regulations, corrective action is required at hazardous waste TSDFs when hazardous constituents are measured in ground water at the unit boundary at levels that either exceed background concentrations or maximum contaminant levels (MCLs) (40 CFR Part 264, Subpart F). Under 40 CFR 264.94, owners or operators of TSDFs may petition to modify their permit conditions to set allowable concentrations of hazardous constituents in ground water to alternative concentration limits (ACLs). ACLs must be based on the hydrogeologic characteristics of the site and the expected threat to human health and the environment resulting from exposure to the constituents. EPA is required to review ACL petitions and make a determination as to whether the suggested values are appropriate and whether the facility permit conditions should be modified accordingly.

3.4.2 Ecological Risk Management in Subpart F Corrective Action

As discussed above, corrective action under Subpart F is triggered when constituent concentrations in ground water exceed background concentrations or MCLs. There is little opportunity for any type of ecological (or human health) risk assessment or management in this process. Ecological receptors are implicitly protected by requiring cleanup when background levels are exceeded. The exception is for constituents with MCLs or MCLGs. Approximately 50 percent of the assigned MCLs or MCLGs are higher than ecological reference concentrations and are thus not protective of aquatic life (i.e., 13 of the 27 MCLs or MCLGs). For example, methoxychlor, toxaphene, mercury, copper, and chlordane all have MCLs or MCLGs that are above ecological reference concentrations. For these pollutants, cleaning up to MCLs or MCLGs will not be protective of the environment. Although the Subpart F program calls for cleanup to MCL levels, rather than MCLGs, the program is nonetheless geared toward protection of humans as opposed to ecological receptors.

Nonetheless, the ACL process provides an important regulatory tool within the RCRA program to implement ecological risk management. Operators of 25 facilities have petitioned EPA or State agencies for ACLs (ACL Fact Sheet. EPA. June 24, 1988). The guidance (see EPA/530-SW-87-017) and regulations for the ACL process clearly require that ecological impacts, as well as human health impacts, should be considered when setting ACLs. In fact, petitioners often base their requested ACLs on ecological toxicity data for the constituents in question, because environmental exposures are more likely than human exposures in many facility settings. Five examples of ecological risk management conducted in accordance with the ACL process are presented below:

- A Union Carbide facility in Woodbine, Georgia, petitioned unsuccessfully for an ACL at the facility's compliance point. An ecological assessment of an adjacent wetlands/estuary indicated

that observed ecological stress might be associated with contaminants originating at the Union Carbide facility. Observations of 100 percent oyster mortality in the estuary in the vicinity of the facility and information on potential exposure to a number of aquatic species in the estuary provided the primary impetus for the denial of the ACL petition. Georgia's Environmental Protection Division (EPD) stated that "as a basis for making this determination [denial of the ACL petition], the Division points to the proposed continuation of discharges of contaminants into an ecosystem currently experiencing stress from other environmental factors, as well as the adequacy of the ACL petition itself." In particular, EPD decided that adequate demonstration had not been made that proposed ACLs would be protective of larval and juvenile crustaceans and fin fish or non-motile organisms such as oysters and clams.

- International Paper Company (IPC) proposed acceptable exposure limits (AELs) for 27 compounds found in contaminated ground water at their treated wood products plant in Joplin, Missouri. The AEL for each compound was equivalent to EPA's drinking water standard, criteria, or other recommended limit. The AELs were used in conjunction with dilution and attenuation factors derived from site-specific hydrogeologic data to determine the ACL for each compound. Although environmental effects were evaluated, they did not factor into the development of the ACLs. A subsequent review by the Missouri Department of Natural Resources (MDNR) and EPA found the proposed ACL demonstration to be deficient. In particular, EPA/MDNR disagreed with IPC's assumption that human health protection will always result in the most conservative ACL value. In response to the petition, EPA/MDNR presented a plan to establish ACLs for pentachlorophenol (PCP) and tetrachlorophenol based on levels protective of freshwater algae as reported in EPA's AWQC for PCP. EPA/MDNR also recommended setting lower ACL values for toluene and naphthalene based on chronic health effects levels for aquatic life calculated from EPA AWQC acute and chronic toxicity data and a site-specific dilution factor (according to a method established by Missouri's Ground-Water Quality program).

- The Southern Dye Company (SODYECO) submitted a petition for ACLs for a variety of Appendix VIII constituents. The petition argued that all contaminated ground water discharged directly to the Catawba River, with no potential human exposures through drinking water wells, at concentrations below acceptable ambient levels based on protection of human health and fish and wildlife. This petition was denied on the basis of an incorrect characterization of site hydrogeology. Although the management decision in this case turned on considerations other than ecological impact, the case does illustrate the manner in which ACLs may be used for ecological risk management.

- National Industrial Environmental Services (NIES) petitioned for ACLs in accordance with a consent order under RCRA and CERCLA. Seventeen of 35 proposed ACLs were based on protection of aquatic life through incorporation of EPA's chronic AWQC or maximum chronic exposure levels derived from acute toxicity data. These ACLs were approved by Region 7.

- A Wyman-Gordon facility operating a treatment lagoon submitted a petition for ACLs for three constituents in its Part B permit application. This petition was subsequently withdrawn prior to its review by the State of Massachusetts or EPA. However, the petition did indicate the operator's intent to provide ecological risk management through the ACL process. This petition requested rather unique ACLs based on ecological studies of a stream and wetland downgradient of the lagoon; the operator proposed ACLs equivalent to the maximum concentrations previously observed at the compliance point and supported this proposal with the demonstration of no biological damage to the stream. This approach to establishing ACLs differs from that used in the previous cases in that the petitioner developed the ACLs based on site observations of ecological and biological conditions, rather than on peer-reviewed toxicological data.

3.4.3 Discussion

In the above cases, ecological impacts were considered through the proposal and review of ACLs. Federal and State officials review the ACL petitions and guide applicants concerning the need for additional information. To support the management of this process, supporting materials are needed both for permit writers and the public:

- Limited policy and guidance stipulating the manner in which ecological impacts should be considered have been developed (see Chapter 10 of the ACL Guidance Document (June 1987), but additional guidance is needed;

- Direction to guide applicants in the presentation of ecological data, identification of sensitive species, and comparison of acute versus chronic exposures;

- Ecological risk policy, guidance, and methodology developed and applied consistently to all corrective action/ACL demonstration cases; and

- Direction available at the initial stages of the process as to when ecological effects should be considered, what ecological effects should be given attention, and what level of ecological impact will warrant Agency action.

3.5 Subpart S Corrective Action

3.5.1 Background

EPA is planning to issue a proposed rule under HSWA authority to create new corrective action requirements at Subpart S of 40 CFR Part 264. The new Subpart S outlines standards and procedures to address releases to air, surface water, ground water, or soil from solid waste management units. The rule stipulates requirements for performing remedial investigations, assessing potential remedies, and selecting and implementing remedies at RCRA facilities.

Under HSWA, all RCRA Subtitle C interim status or permitted facilities must be assessed to determine whether past releases of hazardous waste have occurred at the facility. This is the first step of the Subpart S process and is known as the RCRA Facility Assessment (RFA). If a facility is found to have experienced a release, a more detailed investigation is then carried out to determine the extent of contamination. This second part of the Subpart S process is known as the RCRA Facility Investigation (RFI). Corrective action is triggered at those facilities that are found through the RFI to have released hazardous constituents in concentrations that pose a threat to human health or the environment. In such instances, the owner or operator of the facility is required to conduct a Corrective Measures Study (CMS) to identify alternative remedies. When EPA selects a remedy, the Agency will either issue a follow up order in the case of a facility under interim status, or modify the facility's permit to incorporate the remedy as a condition of the permit. EPA will then oversee the implementation of the remedy by the owner or operator.

3.5.2 Ecological Risk Management in Subpart S Corrective Action

The RFA process is not intended to provide an opportunity for ecological risk management. The RFA focuses solely on identifying releases and potential migration pathways, stopping short of considering ecological or human health impacts. The following case illustrates the general approach of an RFA in accordance with EPA's guidance:

- A Pratt and Whitney facility submitted a workplan for an RFA following the procedures outlined in EPA's RFA guidance of June 19, 1986. The proposed steps of the assessment include a preliminary site review and visual site inspection, to be followed by more detailed investigations (including sampling) if deemed necessary by the initial investigations. The outline of the proposed RFA report indicates that the majority of the discussion will address pollutant migration pathways and evidence of releases to various environmental media with only a "brief description of the potential impacts of any release."

Based on the RFA, a determination is made as to whether a RCRA Facility Investigation (RFI) should be conducted. Given the limited resources available and the large number of sites with past releases that will require

some type of RFI, the Regions must set priorities. To date, EPA Headquarters has provided no guidance to the Regions on setting priorities for RFIs. As a result, the Regions are developing their own priority-setting schemes.

In addition to setting priorities for conducting RFIs, ecological risk may also be considered when completing the RFI. Most of the detailed information used in determining whether a corrective action is needed should be collected during the RFI. However, only a handful of RFIs have been completed at RCRA facilities; therefore it is difficult to assess the extent to which ecological concerns are addressed under the current process. The discussion below provides four examples of facilities at which RFAs and plans for RFIs have been completed and decisions have been made concerning the need for further studies. These examples provide some indication of the manner in which ecological damage information may (or may not) be collected and managed.

- Saco Defense, Inc., is a party to a consent order with EPA Region 1 to conduct a RFI to evaluate "significant environmental contamination." Releases at this site involve seepage of waste solvents and other contaminants from landfills and lagoons to surface water and ground water and volatilization of VOCs to air. The site's RFA identified no ecological impacts. However, the consent order proposes an evaluation of environmental threats to include an identification of nearby wildlife and sensitive areas, and an evaluation of indicator chemicals to be used in assessing environmental risks. Nonetheless, the consent order does not stipulate any specific sampling to be conducted nor does it outline the manner in which the ecological threat information is to be used to evaluate the site.

- Koppers Company, Inc., is a 112-acre wood treatment facility that disposed of its wastewaters through spray irrigation and currently maintains an uncovered product storage area. An RFA has been completed for this facility and an RFI has been recommended. The only ecological impact noted in the RFA was "very sparse vegetation" in several areas. The RFA does recommend, however, that certain solid waste management units (SWMUs) be more closely inspected during the RFI.

- An RFA has been conducted for ARCO's Prudhoe Bay Eastern Operating Area facility. This RFA investigated records of releases at a number of SWMUs and recommended RFIs for a limited number of these units. The decision to perform the more detailed RFIs on a subset of the facility's surface impoundments is based solely on evidence of releases from these units, and not on potential or actual ecological threats. EPA currently has the authority to address only observed releases, rather than potential releases. Ecological impacts are suspected at this facility, however.

- Monroe Auto Equipment Company is not a permitted TSD facility, but it is subject to oversight by the State of Georgia RCRA program as it undertakes remediation efforts comparable to those required under RCRA Subpart S corrective action. In the independent

studies completed to date, the owner has measured the concentration of contaminants in environmental media and compared those concentrations to levels of concern. One comparison relevant to ecological considerations indicates that surface water concentrations of trichloroethene are far below levels of effect for bluegill and fathead minnow. Another toxicity threshold comparison demonstrated that the observed concentrations do not exceed levels of concern for aquatic plants. This study concluded that no further actions are required because the environmental concentrations are below levels of concern for aquatic life and human health.

The Agency could also weigh ecological risk at RCRA facilities when evaluating the results of the RFI to determine whether a corrective measures study is needed at a site. Under the pending draft Subpart S rules, a corrective measures study is triggered if, during the RFI, pollutant concentrations in air, water, or soil are found to exceed action levels for specific constituents. The action levels for all media except surface water are based on human health risk. Under the current EPA guidelines, action levels for surface waters that are designated for uses other than drinking water should be set to protect the designated use (e.g., supporting aquatic life) of the water body. The following case demonstrates the potential use of aquatic toxicity as a basis for determining action levels for a HSWA permit:

- The Southern Wood Piedmont (SWP) Company owns a closed facility in Baldwin, Florida with a draft permit that contains human health-based ACLs. Because the site poses no direct threat to human health, EPA Region IV personnel have decided that the corrective action should be designed to protect environmental receptors. Consequently, EPA personnel have continued investigating the facility to facilitate the development of a site workplan prior to the issuance of a HSWA permit. A toxicity test was performed on ground-water samples taken at the plant boundary. A second round of ground-water sampling and analysis is currently being conducted. Region IV personnel have stated that they hope to use the results of the toxicity testing to aid in developing action levels for releases from SWMUs under the HSWA permit.

There is also opportunity to consider ecological concerns in the corrective measures study itself. At present, very few facilities have reached this point in the corrective action process. As a result, it is difficult to assess the extent to which ecological risk management will occur in the selection of corrective measures.

Two examples of facilities at which ecological risk management issues have arisen during the implementation of corrective action to rectify past releases from a solid waste management unit are provided below. These cases illustrate the need to consider ecological impacts when choosing and designing remedial measures.

- The Kennedy Space Center is voluntarily engaging in corrective action procedures to address releases from a solid waste

management unit. Although the corrective action procedures apparently comply with HSWA requirements, the site has not followed the formal RFA/RFI/CMS process. In consultation with EPA Region IV, Kennedy began work on an air stripper unit to treat contaminated ground water withdrawn from near the facility boundary. However, Kennedy had installed the unit in a Wildlife Refuge adjacent to the Space Center Facility. The Department of the Interior (DOI) raised concerns over the impacts to the refuge wildlife resulting from exposure to the air stripped solvents. Such concerns had apparently not been raised during the earlier stages of the corrective action remedial design. As a result, all activities at the site have been halted pending negotiations among EPA, DOI, and the Kennedy Space Center.

- Allied Chemical Baltimore Chrome Ore Works is currently undergoing negotiations with EPA Region III to address the selection and design of corrective measures. This inactive site has been investigated independently by the owner in a manner comparable to a CERCLA remedial investigation. The results of these previous investigations, which indicate chromium concentrations above levels of concern in ground water and a nearby estuary, are the basis for the corrective measures (e.g., RCRA-type cap and deep ground-water barrier) being negotiated. The ecological impacts at the site include increased body burden of chromium in benthic invertebrates near the site.

A final area of ecological risk management associated with Subtitle C corrective action concerns remediation efforts at facilities that have been moved from CERCLA authority to RCRA Subtitle C corrective action authority. Such transfers of authority may become more common under EPA policy as the Agency endeavors to require privately funded cleanups when RCRA authority can be applied to a site (see 51 FR 21054, June 10, 1986). The following case involves such a transfer of authority at a facility.

- The Rohm and Haas Delaware Valley operation in Bristol, Pennsylvania had been investigated under CERCLA before authority for remediation at the facility was transferred to the RCRA program. The investigative work that has been completed under the CERCLA authority includes a remedial investigation with a survey of plants and wildlife in the vicinity of the facility. This work has focused on a landfill at the facility as the first operable unit for remedial attention. The organization of RCRA corrective action may preclude the use of the information generated in the previously conducted remedial investigations until all SWMUs are identified, their release histories assessed, and their priority for continued study is determined. Only after this RCRA investigation is complete will the opportunity arise for application of the CERCLA investigation results to the RCRA remedial design.

The eventual cleanup action taken at this facility should not differ under the RCRA or CERCLA program. However, there may be a slight delay in remediating

the ecological impacts at the unit as the site may need to comply with the RCRA corrective action requirements.

3.5.3 Discussion

The proposed Subpart S rule gives the remedial investigator discretion in determining if and when an environmental assessment is needed. The ecological scope of the proposed rule is best characterized by the following pertinent sections that implicitly or explicitly pertain to ecological risk management.

Section 264.511 Scope of remedial investigations

(a)(3) Investigations may include, but are not limited to descriptions of humans and environmental systems which have, or under site-specific circumstances are potentially exposed to release(s).

(a)(5) Investigations may include extrapolations of future movement, degradation and fate of contaminants.

Section 264.525(b) Remedy selection factors

(1)(iii) Any potential remedy(s) may be assessed for long-term reliability and effectiveness, and factors that shall be considered in such an evaluation include the potential for exposure of human and environmental receptors to remaining wastes, especially with regard to excavation, transportation, redisposal or containment.

(2)(iv) A potential remedy(s) may be assessed for the level of treatment used to reduce toxicity, mobility or volume of hazardous wastes and constituents. Factors that shall be considered in such an assessment include the propensity of residual hazardous wastes and hazardous constituents to bioaccumulate.

Section 264.525(d) Media cleanup standards

(1)(iii)(B) In establishing remedial cleanup standards the Regional Administrator may consider exposure threats to sensitive environmental receptors.

Section 264.551(b) Management of hazardous wastes

(4)(iv) The Regional Administrator may determine alternate design, operating or closure requirements for some temporary units which store or treat hazardous wastes. If the purpose is to establish standards, the Regional Administrator shall consider, among other factors, the potential for exposure of humans and environmental receptors if releases occur from the unit(s).

Under these pending revisions to the Subtitle C corrective action program, the Agency is moving to a more human health and environmental risk-based approach for determining when corrective action is required and what

cleanup target levels should be set. If the Subpart S program is to aggressively address ecological impacts at RCRA facilities, strong emphasis must be placed on assessing ecological impacts in the RFA/RFI process. At this early stage of the Subpart S program, the critical management need is for sufficient information to assess the extent of ecological impacts at Subtitle C facilities. Hence, the Agency should set policy and develop methods to adequately evaluate ecological damage during the RFA/RFI to ensure that ecological risks are addressed properly during the corrective action.

4. ECOLOGICAL RISK MANAGEMENT IN THE CERCLA PROGRAM

Ecological risk management can occur principally at two points in the CERCLA remedial response process. The first is the decision on whether to place a site on the CERCLA National Priorities List (NPL), and the second is in the development and selection of remedies for individual sites during the remedial investigation/feasibility study (RI/FS).

4.1 Selection of Sites for National Priorities List (NPL)

4.1.1 Background

Once a CERCLA hazardous waste site has been identified, a preliminary assessment and site inspection (PA/SI) are performed. These are relatively brief, initial information gathering activities. A PA is usually limited to a "desk audit" of previously documented information about the release and the characteristics of the site. The SI typically includes a visual examination of site conditions and the collection of samples.

The data gathered and observations made during the PA/SI phase are then evaluated using a site scoring algorithm called the Hazard Ranking System (HRS). The HRS is part of the National Contingency Plan (NCP), the comprehensive set of regulations that implement the CERCLA statute. The HRS is a uniform method for judging the degree of potential hazard presented by a site relative to that presented by other sites. HRS scores are not estimates of absolute risk, but are relative rankings.

If a site receives an HRS score of 28.5 or more, it is placed on the National Priorities List (NPL), which means that further action on the site will occur, and that Superfund monies may be considered as a means of paying for such action. Site hazards will be investigated in greater detail, options for remedying hazards (including a "no action" option) will be developed and evaluated, and one option will be selected and executed. If the HRS score is less than 28.5, the site will not be placed on the NPL unless (1) a State government designates the site as that State's highest priority, or (2) EPA does so based on conditions specified in Section 300.66(b) of the National Contingency Plan.

4.1.2 Ecological Risk Management in Site Selection for the NPL

In most cases, the decision to place a site on the NPL is based on its HRS score. The inclusion of ecological factors in the current HRS is extremely limited; the principal factors score ecological hazard simply in terms of the distance from a site to the nearest "sensitive environment" (the HRS includes a short list of the types of environments that can be considered "sensitive"). This score is built into two more summary scores: the hazard from the site due to the migration of contaminants via surface water, and the hazard due to air migration. These scores are then combined with other summary scores to yield an overall HRS score for the site.

4.1.3 Discussion

Given the current scoring algorithm, ecological risk considerations alone cannot result in a site score of 28.5 or more. Thus, NPL listing is currently not possible for sites where ecological risk is the sole concern. Obviously, sites that score just below 28.5 based on human health risk can be pushed past the threshold based on ecological concerns. Because remedial action is very unlikely to occur if a site is not listed on the NPL, this is a crucial decision point in the CERCLA program, and one in which ecological risk is of secondary importance to human health concerns.

The proposed revisions to the HRS (53 Fed. Reg. 51962, December 23, 1988) will expand the consideration of ecological risk. These HRS revisions expand the list of environments that can be considered sensitive, and incorporate scores that reflect contaminant levels in wastes and surface water relative to ambient water quality criteria and other toxicity values for aquatic species. The larger, more summary components of the HRS have been reorganized to include an "environmental threat" sub-pathway to the surface water migration pathway, and a new "on-site exposure" pathway that includes consideration of sensitive environments. The new threshold score for determining whether or not a site will be placed on the NPL has not been identified. Until the new threshold is established, it is unclear as to whether ecological considerations will be sufficient to qualify a site for listing on the NPL.

4.2 Development and Selection of Site Remedies

4.2.1 Background

After the site is listed on the NPL, a Remedial Investigation (RI) of the site is performed. The RI typically examines the characteristics of the site (e.g., the nature and the extent of the contamination; the principal contaminants involved; land use, human population distribution, and environmental receptors in the area of the site; site geology, hydrology, and wind patterns) in detail. Ideally, the beginning of the RI stage (RI planning) is the point at which CERCLA natural resource trustee agencies are consulted. These agencies are the Department of the Interior (principally the U.S. Fish and Wildlife Service), and the National Oceanic and Atmospheric Administration (NOAA) in the Department of Commerce. These trustee agencies use their ecological expertise to advise EPA on effects a site may have on natural resources (e.g., wetlands), and to determine any liability that parties responsible for site hazards may have for damage to natural resources.[1] The RI is followed by a Feasibility Study (FS), in which possible alternatives for remedial action at the site are formulated and evaluated.

The selection of the actual remedial action to be taken is described and documented in a Record of Decision (ROD) for the site. The ROD first provides

---

[1]Although natural resource damage assessments are supposed to be integrated into the RI/FS and remedial selection process, this report does not focus on the natural resource damage assessment process.

background for the decision by summarizing the data in the RI and FS reports, and then describes the selected remedy and evaluates it according to the criteria by which each of the remedial alternatives were judged.

4.2.2 Ecological Risk Management in Remedy Selection

The selection of the remedial action for a site is the most important ecological risk management event for sites that have passed the HRS/NPL screening process. It is at this point that decisions are made in terms of the remedial actions necessary to protect human health and the environment. A decision concerning remedial action may involve the establishment of specific cleanup levels necessary to reduce ecological risk.

To estimate the frequency with which ecological considerations have historically played a role in remedy selection, RODs were reviewed for 20 sites at which there is some indication of potential ecological problems. The RODs indicate that ecological concerns did not affect remedy selection at almost half of them. In these cases, the RODs typically contain only a general statement of the need to "protect natural resources" or a brief mention of an unspecified potential ecological effect. Sometimes the evaluation of remedial alternatives and the selected remedy is limited to the repeated use of the phrase, "protective of public health and the environment." Little or no description of ecological threats, or of any other non-human health threats that might fall under the term "environment" (e.g., diminished recreational opportunities, materials damage, crop damage) is provided. Some of the RODs clearly stated that sites were near wetlands or other sensitive environments, but did not consider ecological threats on a level of detail approaching what appears warranted.

Nevertheless, there are several CERCLA sites at which ecological effects have been considered in the development or selection of remedial actions. Some examples of how ecological concerns have been or are being incorporated into decisionmaking at CERCLA sites are given below. These examples were identified based on review of the RODs and conversations with Superfund program officials.

At several sites, toxicity testing of ecological receptors has been used in conjunction with chemical testing (e.g., sampling and analysis of sediments) as a basis for determining the need for remedial action, or for identifying the portion(s) of the site that require cleanup. For example:

- Harris Properties in West Virginia is a removal site. Based on chemical analysis of soil samples, there was concern that heavy metals in soils could pose an ecological hazard. To determine whether there was a basis for concern, leachate from soil samples was used in acute and chronic toxicity tests on Selanastrum and Ceriodaphnia. Based on the lack of evidence of lethality or reproductive effects, these tests were used as a basis for justifying no further action at the site.

- Vineland Chemical in New Jersey is in the RI/FS stage. Arsenic-containing pesticides have been discharged into a nearby river

through ground water. A benthic survey was used to determine which areas of the stream show evidence of ecological impacts and therefore require remediation (such as dredging). In this survey, macroinvertebrates were collected from areas upstream and downstream of the site. Areas recommended for remedial action based on ecological effects were those that displayed a statistically significant change in one or more of several different indices (e.g., species diversity, richness, number of taxa present, functional feeding group assessments). Toxicity testing on solid phase (sediment) samples was used to correlate effects in the benthic population with laboratory-controlled studies on benthic invertebrates. These same techniques (benthic surveys combined with toxicity testing) are being used as a basis for delineating the portion of the site requiring remediation at Clear Creek, Colorado, which is in the RI stage.

- Oconomowoc Electroplating in Wisconsin is a remedial and removal site. The focus of ecological concern is elevated levels of heavy metals and cyanide in a nearby wetland. Sediment samples are being tested for toxicity to fathead minnows and Selenastrum; the endpoints of concern are death and decreased growth. The results of these tests will be used to delineate the boundaries of site contamination and determine the need for remedial action.

- Myers Property, a chemical formulator in New Jersey, is in the RI/FS stage. Chemical monitoring has shown highly elevated DDT levels in the soils of a nearby forested wetland that receives surface runoff from the site. Removal of the DDT is being considered based on potential effects on small mammals that could bioaccumulate DDT. Because DDT removal will destroy a valuable habitat, the Agency is trapping small mammals to determine whether DDT accumulation has in fact occurred, and whether DDT removal is justified.

- At the Marion/Bragg inactive landfill in Indiana, the focus of ecological concern is the high levels of ammonia and arsenic on-site, which could cause ecological effects in a river that receives ground-water discharge from the site. Ammonia levels in some river water samples exceeded Indiana WQC for the protection of aquatic life, but no adverse effects on aquatic life were detected. Risk managers considered constructing a slurry wall and pumping and treating ground water to prevent discharge of contaminants to the river, but its high cost could not be justified in light of the lack of actual damage to aquatic life in the river (as well as technical inadequacies). An "interim remedy" was selected which includes restricting access; regrading and construction of a clay cap; construction of a levee to control flooding; quarterly monitoring of both the river and the ground water entering the river; and a series of studies on the aquatic life of the river. These studies will include fish toxicity tests using indicator chemicals for volatile organic compounds, PAHs, and inorganics. They will also include "general toxicity tests"

to determine if ammonia or other constituents in the ground water cause a toxic effect on the aquatic environment; these general tests may be modeled after toxicity tests that NPDES dischargers are subject to. Based on the quarterly monitoring, the toxicity tests, and observations on the performance of the interim measure, the need for a more complete remedy will be assessed.

At several sites, performance or cleanup levels for the remedial actions are being set at concentrations intended to be protective of ecological receptors. Also, at sites for which ground-water extraction and treatment is among the remedial alternatives, ecological considerations are frequently taken into account in setting effluent limitations for the treated ground water. For example:

- The Marathon Battery site in New York discharges into Foundry Cove, a shallow bay and cattail marsh on the Hudson River. Elevated levels of cadmium, nickel, and lead were found in surface water, sediments, and biota at the site, including fish and mammals. The main remedial objectives were to prevent biota from contacting contaminated sediments that would threaten them, and to prevent resuspension and redistribution of contaminated sediments that would threaten flora and fauna. To evaluate remedial alternatives, it was necessary to establish an acceptable level of cadmium in sediments. The effects of elevated metals levels were examined in terms of both ecological and human health endpoints. A cadmium level of 900 mg/kg in sediments was deemed acceptable to protect public health. To identify an cadmium level in sediments that would be acceptable from an ecological standpoint, a partitioning approach was used to determine the sediment level that would limit cadmium concentrations in the water column below the AWQC. A site-specific remediation level of 100 mg/kg was ultimately selected to protect against the threat to the environment. The remedial action selected for the Foundry Cove marsh was sediment dredging, chemical fixation, and off-site disposal; restoration by addition of clean fill and clay with a high affinity for cadmium and revegetation; and long-term monitoring of sediments and biota.

- At the Geiger site in South Carolina, contamination by lead, chromium, and organics was detected in soils, ground water, and nearby swamp and wetland areas; these wetland areas are critical habitat for endangered species (bald eagle, wood stork, red-cockaded woodpecker), threatened species (American alligator), and other species being considered for future listing. The ground water underlying the site has been identified by EPA as Class I because it discharges to wetlands. The selected remedial action was ground-water extraction, treatment, and discharge; and on-site soil excavation, thermal treatment, stabilization/solidification, and backfilling at the site. The ground-water cleanup levels were driven by ecological considerations; the cleanup levels for toluene and 1,1-dichlorobenzene were based on aquatic chronic

toxicity values. Effluent limits for the ground-water treatment system are to be based in part on toxicity tests.

- At Re-Solve, Inc., in Massachusetts, PCBs and other contaminants (methylene chloride, phthalates, cadmium, mercury) have been detected in both surface water and sediments of a nearby wetland, in a river designated by the State of Massachusetts for the protection and propagation of aquatic life and wildlife, and in a pond used for sport fishing; ground-water contamination has also occurred. Site remedies include excavation and PCB removal from on-site soils and wetland sediments, followed by recirculation (pump, treat, recharge) of contaminated ground water, and revegetation. The PCB cleanup levels for the soil and ground water were based on human health; the PCB cleanup level of 1 ppm for the wetland sediments was based on ecological criteria. According to the ROD, the 1 ppm PCB cleanup level in sediments is protective of "some but not all adverse effects" on freshwater benthic organisms, and will result in a water column level below the AWQC; fish tissue levels, however, "may exceed the FDA tolerance limit." A less stringent cleanup level of 2.5 ppm was rejected as being not sufficiently protective of aquatic life.

- At the Mowbray site in Alabama, the areas of ecological concern are a swamp with stressed vegetation, and a stream that receives contaminated runoff and ground-water discharge from the swamp. The principal contaminants are waste oils and PCBs. Site remedies included cleanup of waste oils, excavation and incineration of contaminated soils, drainage rerouting, and restoration of the swamp area (backfilling, grading, revegetation, fertilization). The cleanup level for PCBs in soils in the swamp was set at 25 ppm, after an analysis indicated that cleanup of soils to this level would ensure compliance with AWQC in the nearby stream.

- The Outboard Marine site in Illinois has resulted in PCB contamination in Waukegan Harbor. PCB levels in the harbor exceed AWQC, and elevated PCB levels have been detected in fish, shellfish, and waterfowl. A decreased species diversity of benthic macroinvertebrates has been noted, and there is a "relative scarcity" of fish in the area. Endangered or threatened species believed to be in the area include the bald eagle, lake whitefish, and several species of birds and plants. The remedial action involves the excavation of sediments containing more than 50 ppm of PCBs. This level was selected to ensure that water column concentrations of PCBs would not exceed the chronic AQWC, and that fish tissue levels would not exceed the FDA action level. A hydrodynamic model of water and sediment transport was used to determine the relationship between sediment and water column concentrations; a safety factor of 2 was then applied to the model results.

- At the Takoma Landfill Site at Commencement Bay, Washington, ground water contains heavy metals and organics at levels above

AWQC. Although surface water contamination is not currently a problem, there is concern that discharge of contaminated ground water to creeks could result in surface water concentrations above AWQC; these creeks support anadromous salmonid runs which could be at risk if toxic compounds are present during critical phases in their growth cycles. There is also concern that discharge from the creeks to Puget Sound could adversely affect vulnerable larval fishes and commercially important shellfish. The remedy selected is capping of the landfill, extraction of methane gas, and ground-water extraction and treatment; these controls will prevent further contaminant migration and thereby protect both human health and the environment. Ten constituents of concern were identified, 8 based on human health and 2 (toluene, xylenes) based on potential ecological risk. Although the ground-water cleanup levels will be based on human health-based criteria, potential impacts to the creek must be considered in a decision to shut off the pump and treat operation. Also, levels of the 10 constituents of concern in effluent from the ground-water treatment system cannot exceed MCLs or AWQC if the effluent is to be discharged to surface water. Toxicity tests will also be used as a basis for developing standards for treatment system effluents.

In several cases, ecological considerations have led to the elimination of certain remedial alternatives judged to have unacceptable ecological impacts. Some examples, given below, illustrate the trade-offs that are often made between the environmental benefits and damages that can result from a remedial action.

- As discussed above for the Re-Solve site in Massachusetts, a cleanup level of 1 ppm for PCBs in sediments was selected based on ecological concerns. This sediment criterion will result in water levels below the AWQC. However, the ROD recognizes that this PCB level is not protective of all adverse effects on freshwater benthic organisms, and can result in fish tissue levels above the FDA tolerance limit. A more protective level cleanup level of 100 ppb was rejected at this site because it would double the wetland area disturbed, resulting in increased loss of flora and fauna.

- At the Geiger site described above, excavation of contaminated sediments in the swamp was rejected (in favor of extraction and treatment of ground water and on-site soils) because it would require clearing the vegetative cover, which would disrupt the habitat and feeding groups of a wide variety of wildlife. The ROD stated that "benefits to be obtained by swamp remediation would be exceeded by the adverse environmental impacts which would be realized."

- At Mobray Engineering, discussed above, the remedial action included excavation and incineration of contaminated soils, followed by restoration and revegetation of the swamp. On-site encapsulation of contaminated soils was rejected because it would limit the ability of the site to be revegetated. Similarly,

stabilization/solidification of the contaminated soils was rejected because it would result in "permanent loss of wetland resources in areas where soils are solidified."

At some sites, the selected remedial action is known to be unable to comply with ecologically-based ARARs. This has been justified in some cases based on the fund balancing provision of the NCP (40 CFR 300.68(i)(1). This provision allows EPA to choose a remedy that does not meet ARARs when the need for complying with ARARs is outweighed by the need for action at other sites, given the total amount of money available in Superfund. Thus illustrates another trade-off issue, i.e., the need for remedial action at one site versus the availability of funds for remedial actions at other sites.

- At the Iron Mountain Mine site in California, releases via runoff and ground water from the inactive mine have contaminated surface waters and sediments. Cadmium, copper, and zinc have been detected in fish and aquatic invertebrates, and there have been documented fish kills. The selected remedy is capping the mine to reduce infiltration of clean water, diverting runon, and assessing the feasibility of using concrete to reduce acid drainage from the mine. This remedy will not reduce metals in surface water to levels below the AWQC, nor will it protect the winter run of an endangered species of salmon. A more expensive remedial alternative (removal of waste rock, tailings piles, and sediments) that could have met the ARARs was rejected as too costly ($1.4 billion) under the fund balancing provision of the NCP.

- At the Outboard Marine site in Illinois, discussed above, the selected remedial action was to remove sediments with PCB levels above 50 ppm. This was selected in place of excavating all PCB-contaminated sediments, which, according to the ROD, is the only alternative that would have been in compliance with the Toxic Substances Control Act (i.e., would meet all ARARs). This remedy, however, would have cost over $75 million, about three times more than the selected remedy, and was rejected based on the fund balancing provision.

Other examples of how ecological concerns have been addressed at CERCLA sites are provided below:

- PCB contamination is of concern in the Hudson River in New York. PCB levels in fish tissue have exceeded the FDA action level. PCB concentrations in sediments are over 50 ppm in some "hot spots," exceed 20 ppm in "cold areas," and are over 10 ppm in areas further downstream. An "interim" no action alternative was selected for this site. Dredging of contaminated sediments was rejected because it would result in releases of PCBs into the water column, and because its expense could not be justified based on the level of risk at the site and the need for actions at other sites. Also, natural sedimentation processes appear to be covering up the PCB contamination, making the chemical less accessible to biota; in fact, there has been a downward trend in

PCB levels in fish tissue. However, site personnel are not convinced that remedial action should not be taken at the site. Further investigations are being conducted to characterize the contamination more completely, and new technologies for PCB remediation are being investigated.

- The Palmerton Zinc site consists of areas contaminated by a zinc smelter in a deep valley of the Appalachian Mountains in Pennsylvania. Releases from the Blue Mountain Operable Unit has led to defoliation on one side of Blue Mountain, and contamination of a creek that receives runoff from the mountain. The contaminants of concern are cadmium, zinc, and lead, which are 400 to 2,600 times background levels in soil, 22 to 64 times the 4-day AWQC in runoff, and are elevated in fish tissue. The selected remedy calls for revegetation of the defoliated areas using a mixture of sewage sludge and fly ash, and seeding (grass and trees). The remedy is aimed at protecting existing ecological resources and fostering new growth and ecological diversity on the mountain. Its effectiveness in terms of improving the water quality of the stream is not assessed quantitatively in the ROD, nor are the AWQC for metals established as ARARs; these steps will be reserved for consideration with respect to two other units at the site. The sole ARARs for the creek are the "best management requirements" of the Clean Water Act concerning minimization of erosion and runoff; an erosion and sedimentation control plan will be developed. ARARs for the revegetation operation will be the State's 1977 "Interim Guidelines for Sewage Use for Land Reclamation," which set limits on metals levels in the sewage and establish soil pH goals. The only alternative remedies considered were the "no action" alternative and placement of restrictions in property deeds prohibiting residential, agricultural, or other uses of the property.

- At the West Virginia Ordnance Works, the main area of ecological concern is the McClinton Wildlife Station, which was developed for the propagation of fish and waterfowl and covers about a third of the site. The selected remedy consists mainly of burning nitroaromatics found on surface soils and around subsurface sewer lines; the burned areas will be covered with soil and revegetated. The cleanup decisions appear to be driven by the desire to protect the recreational use of the site for hunting, although the selected remedial action will also protect aquatic life in pond waters. The soil cleanup level is based on protection of hunters; revegetation will remediate wildlife habitat. A "wetlands assessment" will be performed before construction activities begin, in which an experienced biologist/wetlands ecologist will identify wetlands that are in the area of the proposed remedial action. Impacts to wetlands will be avoided or mitigated. The wetlands assessment is intended to comply with Section 404 of the Clean Water Act.

- The New Castle Steel site in Delaware has released lead and other metals (arsenic, cadmium, chromium, nickel) into a tidal marshland along the Delaware River. The "no action" alternative was selected based on the lack of human health and ecological risk. Surface water samples from the marsh contained lead levels twice as high as the AWQC, but background levels upstream are even higher, indicating that the inactive landfill is not the major source of contamination. Included in the no action alternative is a plan to monitor lead concentrations in and around the marsh to evaluate the potential adverse effects of lead and to identify the principal contaminant sources. If continued efforts to reduce lead discharges upstream make the site a relatively larger contributor to contamination, further remedial action might be required. Monitoring will continue until the site is deleted from the NPL, or closed under Delaware's solid waste disposal regulations. The ROD notes that NPL deletion does not disqualify the site for Superfund financing of any remedial actions that may be deemed necessary based on further monitoring.

- The Crab Orchard site in Illinois is the site of a National Wildlife Refuge. Elevated levels of lead have been detected in terrestrial biota. In Crab Orchard Lake, both PCBs and mercury in fish tissue have exceeded FDA action levels. PCBs and cyanide levels in the surface water of Crab Orchard Lake have exceeded AWQC for the protection of aquatic life. The sediments are also contaminated with arsenic, PCBs, and other organics. The Crab Orchard site is currently in the FS stage. Because the site is owned by the Department of the Interior, DOI rather than EPA is responsible for remedial actions.

- The Munisport site in Florida, a landfill that has led to contamination of a mangrove swamp, on-site lakes, and soils, is currently in the FS stage. Although no explicit ecological risk management decisions have been made at this site, it is noteworthy with respect to its relatively detailed assessment of potential effects on terrestrial species. A literature search was conducted for the purpose of deriving information on the toxicity to terrestrial life of several different compounds found at the site. Information was collected on the toxicity of arsenic, chromium, mercury, nickel, DDE, and PCBs to birds; and of cyanide, manganese, phenol, and vanadium to mammals. These toxicity values were then compared to expected exposure levels for the species of concern. This types of quantitative assessment of potential terrestrial effects has rarely been seen at CERCLA sites.

Although ecological risk management has not historically played a significant role in remedy selection, it is clear that ecological concerns are receiving increased attention in some of the EPA Regions. Biological technical assistance groups have been formed in some EPA Regional offices to assist CERCLA site managers in making sure that site activities fully consider ecological risk. EPA Region 3 has had a biological technical assistance group for about four years, a group has been operating for longer than a year in

Region 2, and groups have been formed in Regions 1, 4, and 10. Regions 5, 6, and 9 are well along in developing biological technical assistance groups, and Region 8 is beginning to address how a group would be utilized if it were organized. These groups have been supported through the Emergency Response Division and the Hazardous Site Evaluation Division for over two years. The goal of these groups is to provide specific technical recommendations to site managers during the RI/FS process, and apparently to a lesser extent in the actual selection of remedy. These recommendations may be accepted or rejected at the discretion of site managers.

In order to ensure the efficient, coordinated communication of ecological risk information essential to effective ecological risk management, biological technical assistance groups comprise officials not only from EPA, but also from agencies with responsibility for trusteeship of natural resources under CERCLA (DOI, NOAA, and State government agencies). The representation of these other agencies in the groups allows site managers to make maximum use of their varied expertise, and to learn about the concerns of the other agencies early enough in the remedial response process to allow them to be fully addressed. Biological technical assistance groups can also be used to resolve disagreements between agencies on the appropriate course of action at a site.

After reviewing the current documentation for a site (usually an RI workplan or a draft RI) and meeting with the manager for that site, biological technical assistance groups generally (1) identify ecological concerns, (2) determine data needs, and (3) make recommendations. The types of ecological concerns identified include any CERCLA natural resources that may be affected by the site (e.g., estuaries), and may therefore require a determination by the relevant natural resource trustee regarding any liability of potentially responsible parties (PRPs) for damages to those natural resources. In addition, the group identifies the contaminants of ecological concern at the site, and the pathways along which contaminants may migrate to ecological receptors. The data needs usually pertain to the extent and the character of contamination in specific areas (e.g., a stream), media, and pathways of the site that are of ecological concern.

Biological technical assistance group recommendations to site managers consist primarily of specific instructions to use particular endpoints and assessment methods to satisfy the data needs spelled out earlier. These recommendations are phrased in terms of monitoring activities, sampling plans, toxicity tests, and other analytical techniques to be used with respect to specific site areas and receptors (e.g., benthic infaunal communities in river sediments). Recommendations can also identify specific ARARs that serve as thresholds for action (and with which compliance is necessary), as well as some of the beneficial and detrimental aspects of possible remedial alternatives. For example, the biological technical assistance group in Region 2 recommended that any discharge associated with a remedial alternative selected for a particular site comply with specific State criteria for ocean and river discharges. The same group also recommended that at another site, any water that may be contaminated by sediments dredged from a lake (if dredging is chosen as a remedial alternative) not be allowed to flow

downstream through a spillway, and that AWQC for site contaminants not be exceeded.

4.1.3 Discussion

It is apparent that although human health concerns have driven remedial actions in the past, ecological considerations are being taken into account more frequently in site-specific cleanup decisions.

Many factors have contributed to the past lack of consideration of ecological risk in remedy selection. The most frequently cited cause for the lack of effective ecological risk management is the absence of clear policy or guidance that articulate the extent to which ecological data should be collected and used in the remedy selection process. The absence of policy or guidance in many cases is due to a lack of appropriate scientific knowledge and data, and additional fundamental research addressing these data gaps clearly is needed. However, some policy decisions could be reached given current knowledge and data. For example, probably the most fundamental risk management issue is the selection of appropriate biotic receptors and ecological effects to evaluate. There is a virtually infinite number of combinations of receptors and effects that can be considered at a site. However, there currently is no policy or guidance for Superfund managers on which receptors and endpoints should be assigned priority in terms of evaluating and minimizing effects (e.g., Should impacts directly related to human health concerns or involving species with economic value be given priority?) Given current ecological knowledge, it should be possible to identify a set of receptors, endpoints, and levels of concern to be assigned priority at Superfund sites. In addition, limited policy and guidance exists on how to interpret ecological survey and toxicity test results.[2] Therefore, even when extensive ecological assessments are conducted, site managers have virtually no basis for judging the acceptability of ecological damages and risks, or determining "how clean is clean."

A recent memorandum (dated December 28, 1988) from the Directors of OERR and the Office of Waste Programs Enforcement to Regional Division Directors provides a useful statement of policy concerning the need to evaluate ecological issues in Superfund remedial actions and removals. The CERCLA program is also currently in the process of revising some of its guidance documents, and is preparing several new ones. However, neither the recent policy statement nor the forthcoming guidance documents provide complete answers to the kinds of questions outlined above. The extent to which these documents address ecological risk is discussed below.

---

[2]Guidance for denoting levels of concern for toxicity tests has been developed for the NPDES permitting process. (See two EPA Office of Water reports; one entitled "Technical Support Document for Water Quality-Based Toxics Control, September 1985, EPA-440/4-85-032; the other titled "Permit Writer's Guide to Water Quality-Based Permitting for Toxic Pollutants," July 1987, EPA-440/4-87-005.)

- The 1985 version of the RI/FS guidance is being revised to incorporate changes in SARA and the NCP. The latest revision, "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA," August 1988, identifies general types of environmental data that should be collected and possible sources for some types of data. It emphasizes the need to examine environmental threats as part of site characterization, development and evaluation of alternatives, and baseline risk assessment. It also identifies environmental protection as a criterion in screening and comparing remedial action alternatives. However, it does not address the major issues identified above as important by CERCLA personnel. Although many of these issues cannot be answered at the present time, the usefulness of the guidance in promoting consideration of ecological risk in the RI/FS process could be improved by: (1) adding language stressing the need for some type of measure for comparing the effectiveness of each remedial alternative in reducing environmental risk; (2) emphasizing that a key planning step should be to investigate various ecological assessment methods and attempt to select the best method at an early stage; (3) emphasizing the need to identify and coordinate with potentially affected natural resource trustees; and (4) revising the baseline risk assessment discussion to include expanded discussions on the types of ecological receptors of possible interest, the types of endpoints that may be addressed, and the level of impact that could be considered significant.

- OSWER's "Risk Assessment Guidance for Superfund -- Environmental Evaluation Manual" (Draft Interim Final, March 1989) is intended to help Remedial Project Managers and On Scene Coordinators manage ecological assessments during the RI/FS and removal processes. The manual discusses several important topics that should be considered when managing an ecological assessment under Superfund, including an overview of relevant statutory authorities and guidance, basic ecological concepts, when and how to coordinate with ecological experts, key types and potential sources for environmental data, and basic questions that will commonly be asked during an ecological assessment. The manual is an excellent primer on ecology and ecological impacts, but does not provide specific guidance on how to resolve key issues such as the appropriate level of detail for an ecological assessment, how to choose appropriate assessment methods, how to interpret the results of an ecological assessment, and when it is appropriate to take action to mitigate ecological concerns. Instead, the manual emphasizes the need for site managers to coordinate with technical experts to resolve these issues on a site-specific basis.

- Two other guidance documents are being prepared as companions to the Superfund Environmental Evaluation Manual: the OIRM "Ecological Resource Information Directory" and the ORD "Ecological Assessments of Hazardous Waste Sites Methods Manual." The OIRM directory will identify useful sources of ecological

data, including experts in the field of ecology who can be contacted for information, and the ORD manual will describe field and laboratory methods for ecological assessments.

- Several drafts of a revised ROD guidance document have been produced to reflect changes in the NCP. The latest draft, "Interim Final Guidance on Preparing Superfund Decision Documents: The Proposed Plan and Record of Decision," March 1988, appears to contain only limited consideration of ecological risk. Apparently, then, the consideration of ecological risk in ROD guidance has not expanded and developed along with the implementation of SARA and the expansion of ROD guidance in general.

- Guidance documents on identifying and complying with ARARs have been drafted that include a brief discussion of ecological ARARs. Although these guidance documents are still in draft form, Regional personnel have already been trained to use them, and it is likely they have already begun to be used for some site selections of remedy.

A lack of ecological assessment data is also frequently cited as a major hindrance to effective ecological risk management. For many ecological risk assessments, the level of analysis is minimal, and they tend to be qualitative rather than quantitative. In addition, the assessment methods vary greatly from site to site depending in part on the interests and backgrounds of site managers. Assessments are usually limited to parts of, or adjuncts to human health risk assessments. Assessment of ecological impacts at the population and ecosystem levels has been particularly lacking. EPA Regional personnel remarked that bioassessment (assessment of contaminant levels in sampled biota) is done relatively infrequently, and that current bioassessment efforts are incomplete and need improvement. Interviewees also suggested some of the root causes of the current inadequacies in ecological risk assessment. These include the lack of methods for assessing ecological effects quantitatively; the inadequate implementation of good ecological risk assessment methods; insufficient knowledge about ecosystems; a lack of personnel qualified to perform ecological assessments; a lack of criteria by which to judge ecological risk; and a lack of resources to do the field sampling necessary for ecological risk assessments.

As discussed above, ecological risk management is being performed increasingly in the remedy selection process through the formation of biological technical assistance groups in several EPA Regions. The formation of these groups has been encouraged by CERCLA program headquarters. The influence of biological technical assistance groups has probably been reflected in selections of remedies at a few sites. These efforts can be expected to bring about further improvements in remedy selections in the near future. Biological technical assistance groups may bring even greater benefits in the longer term as their use expands to other Regions. However, the useful guidance provided from these groups still suffers from limits on available resources, personnel, and standards.

5. SUMMARY/PROGRAM IMPLICATIONS

This section summarizes the results of the analysis and discusses program implications, first for RCRA and then for CERCLA. The section concludes with a discussion of cross-program ecological risk management issues.

5.1 RCRA Programs

This analysis indicates that in general, ecological concerns have not played a significant role in past regulatory development or site-specific decisionmaking in the RCRA program. RCRA regulations have historically been geared toward protection of human health, and have been justified in terms of their benefits to human health. Ecological risk management has been virtually non-existent in the listing and delisting of hazardous wastes, and there is no indication that future listing and delisting decisions will consider the inherent ecological toxicity of waste streams. In the permitting program, ecological assessments are not required in permit applications for new facilities. Ecological risk management in RCRA appears to be limited to ACL demonstrations and Subpart S corrective action. Overall, it appears that ecological concerns are addressed in the RCRA program only if there is evidence of a past release.

To increase the consideration of ecological concerns in RCRA rulemakings, program needs include:

- clear statements of policy requiring the analysis of ecological impacts in benefits and impacts assessments;
- protocols for use over the short term for incorporating qualitative measures of ecological impacts in rulemaking decisions;
- guidance and methods to be developed over the long term for improving the quantitative measurement of ecological impacts; and
- clear identification of the threshold levels of ecological impacts that warrant rulemaking action.

To promote ecological risk management in site-specific decisions, needs in the permitting program include:

- providing a mechanism by which people with the appropriate expertise (either from EPA or other agencies) can be brought into permit reviews earlier in the process; and
- requesting and reviewing more detailed ecological impact information whenever human health impact data is considered as part of a permit application.

Management of ecological risks in the Subpart F corrective action process could be improved by developing guidelines for assessing impacts to ecosystems when human health damage is not a concern, and publishing criteria to assist permit writers in evaluating the variety of data that may be submitted with ACL petitions.

In the new Subpart S corrective action process, EPA should ensure that sufficient data is collected during the RFA/RFI assessment stages to identify ecological impacts accurately, and to guarantee that ecological impacts are considered along with human health impacts when site-specific corrective action priorities are set.

Improvements to the listing/delisting processes would include expanding existing models to consider pathways other than ground-water transport, setting TC regulatory levels at concentrations protective of ecological as well as human health receptors, and evaluating delisting petitions in terms of potential ecological effects.

5.2 CERCLA Program

The activities of the CERCLA remedial response process in which ecological risk management can occur are of three basic types: collection of information on site ecological concerns; analysis and evaluation of this information; and decisionmaking based on the evaluations. Although only the actual decisionmaking constitutes explicit ecological risk management, information collection and evaluation can also be considered ecological risk management activities because they provide the foundation on which ecological risk management decisions rest.

The initial phase of the remedial response process, the Preliminary Assessment and Site Inspection (PA/SI), primarily involves information collection. A scoring evaluation of data from the PA/SI by the Hazard Ranking System (HRS) is used to decide whether a site should be included on the National Priorities List (NPL) of sites requiring more detailed investigation. The inability of a site to score high enough to be included on the NPL based on ecological impacts alone severely hinders effective ecological risk management. Revisions to the HRS significantly expand its treatment of ecological concerns, but it appears that sites will still have to pose substantial human health threats in order to qualify for the NPL.

After being placed on the NPL, sites undergo a Remedial Investigation (RI) that analyzes and evaluates site hazards in greater detail. Together with the Feasibility Study (FS) of alternatives for remedial action, the RI constitutes the base of information used in remedy selection for the site. Unfortunately, ecological assessments are often incomplete, probably because of an emphasis on human health versus the environment in the CERCLA program generally, the lack of needed ecologically-based standards (ARARs) and personnel trained to use them, and the fact that the funding available in the CERCLA program cannot address all concerns at every site. The limited but growing use of biological technical assistance groups in EPA Regional offices has improved the consideration of ecological effects during the RI/FS phase and should bring even more improvement in the future. However, the useful

guidance provided by these panels still suffers from limits on available standards, personnel, and resources.

The rationale for selecting a remedial action for a site is documented in a Record of Decision (ROD). An examination of selected RODs supplemented by observations from CERCLA program personnel reveals that while ecological concerns are sometimes addressed thoroughly, most RODs omit at least some important ecological considerations (e.g., AWQC), and many RODs contain little or no explicit treatment of ecological impacts. Where ecological risk management does occur, it usually involves decisions on (1) the effectiveness of a remedy in achieving compliance with ecologically-based ARARs; (2) the acceptability of adverse environmental effects created by the remedial action (e.g., the dispersal of contaminants in a wetland due to excavation of sediments); and (3) the trade-off between the need for remedial action at a site and the availability of funds for remedial actions at other sites. Also, toxicity testing of environmental receptors is being used more frequently as a basis for determining the need for remedial action, or for identifying the portions of a site requiring cleanup.

Consideration of ecological impacts in remedy selection can probably be most improved by ensuring a more complete inclusion of ecological risk in the RI/FS phase, and by indicating the importance of explicitly ecological considerations in CERCLA guidance documents. Draft revisions to existing CERCLA guidance, and new draft guidance documents such as the Superfund Environmental Evaluation Manual, will encourage the extent to which ecological impacts are investigated at sites. However, because the Superfund Environmental Evaluation Manual provides little direction on how to interpret the findings of ecological site investigations, it is not likely to resolve (and might, in fact, exacerbate) inconsistencies in risk management decisions among sites. Recommendations of the biological technical assistance groups on ARARs and remedial alternatives have been helpful, and should be even more so in the future.

5.3 Cross-Program Ecological Risk Management Issues

This section identifies some fundamental ecological risk management issues that will need to be addressed as EPA attempts to incorporate ecological concerns into its RCRA and CERCLA site and program activities.

Probably the most fundamental risk management issue is the selection of appropriate ecological effects to evaluate. There is a virtually infinite number of combinations of receptors and effects that can be considered at a site. Which receptors and endpoints should be assigned priority in terms of evaluating and minimizing effects? More specifically, should impacts directly related to human health concerns (e.g., consumption of contaminated fish tissue) or involving species with economic value be given priority? Another important issue is whether the selection of appropriate receptors and endpoints should be based on program-wide (or Agency-wide) policy, or whether the decision should be made on a site-specific basis.

Once the appropriate receptors and endpoints have been identified, a decisionmaker must determine the appropriate threshold for taking action. This

requires a policy decision regarding the familiar "how clean is clean" question, or the definition of a de minimis ecological risk. As above, it is unclear as to whether this determination is made more appropriately on a program-wide or site-specific basis.

Another major issue is the monetization of ecological damage. For example, a valuation of ecological damage may include aesthetics, effects on recreation, effects on agricultural production, overall public desire for environmental quality, and the loss of societal well-being from species extinction or other irreversible effects. When is it appropriate to express ecological damage in dollar terms? Such analyses may be supported by the use of the CERCLA Type B natural resource damage assessment methods developed by the Department of the Interior.

Given that neither the RCRA nor the CERCLA program have unlimited resources for carrying out their mandate to protect human health and the environment, each program must set priorities for addressing ecological concerns, both within and among sites. Priority-setting requires resolution of a host of tradeoff issues. For example, when should ecological concerns be incorporated into cleanup decisions, particularly in relation to concerns related to human health; and what is the appropriate balance between the use of resources for protecting human health versus the environment? In the process of ranking sites or selecting remedial actions for a specific site, which ecological impacts should be given priority? What is the appropriate decision process in choosing between the need for immediate cleanup at a site and the need for thorough and time-consuming evaluation of ecological threats posed by a site?

An important institutional issue faced by both RCRA and CERCLA programs is how to determine whether ecological risk management activities in the programs are being conducted successfully.. Determinations should be made periodically to verify the effectiveness of Agency actions in achieving policy goals. For example, success in the CERCLA program can be defined in terms of the number of sites at which remedial actions have been completed; this measure does not, however, indicate the extent to which the program has resulted in increased protection of the environment. How to evaluate the performance of an ecological risk program as a whole needs to be defined. More specifically, what are the appropriate endpoints and indicators (e.g., economic, social, and political) of effective ecological risk management? What methods or guidelines should be established to weigh/rank the many parameters that may be involved? Should management indicators of effectiveness be used on a site-specific basis, on a program-wide basis, or both? Several of these issues are being addressed by the CERCLA program as part of the "Superfund indicators" project; they have not yet been addressed for the RCRA program.

Finally, if ecological risk management is to be firmly incorporated into EPA hazardous waste programs, impediments to ecological risk management that arise from legal authorities must be identified. Do statutory and judicial mandates, such as requirements to consider cost-effectiveness or to use a particular type of technology, constrain effective ecological risk management? CERCLA, RCRA, and the court cases bearing on these statutes may often conflict

with and constrain risk reduction efforts, or they may affect the legal defensibility of ecological risk management decisions. In particular, the differing mandates of CERCLA and RCRA may make the consistency of ecological risk management across the two programs difficult.

Many of the issues identified above have already surfaced in the CERCLA program, and appear to be receiving increased attention in RCRA programs, particularly with respect to RCRA corrective actions. As the discussions of ecological risk management at CERCLA sites (Section 4.2) indicates, when ecological risk management issues arise, they are generally resolved on a site-by-site basis. If ecological risk-based decisionmaking is to be conducted with some consistency both within and across programs, there is a need for EPA to develop policies for addressing these important ecological risk management issues.